The goal of this project is to develop modern glass-ionomer cements (GICs) for dental applications, featuring improved mechanical properties, wear resistance, and antibacterial functionality. Glass-ionomer cements are widely used in dentistry as restorative materials due to their biocompatibility, ability to bond with tooth tissues, and fluoride release, which aids in caries prevention. However, their limited resistance to wear and cracking under challenging oral conditions presents a significant challenge that this project seeks to address.

The innovation lies in introducing solid lubricants, such as hexagonal boron nitride (hBN), and reactive glasses doped with samarium oxide (Sm^{3+}) into GIC formulations. hBN, a well-known material in engineering for reducing friction and wear, is expected to enhance the tribological performance of GICs. Additionally, Sm^{3+}, with its similarity to calcium (Ca^{2+}) and low toxicity, strengthens medical glasses while providing strong antibacterial properties, including activity against drug-resistant bacteria. Together, these modifications aim to create a more durable and functional dental material.

The project will involve both the production of new materials and their comprehensive analysis. The developed cements will undergo mechanical and tribological testing simulating oral conditions to assess their resistance to wear and degradation. Furthermore, advanced computational methods, such as nonlinear analysis and predictive modeling, will be used to understand wear mechanisms and predict material behavior under various clinical scenarios.

This research is driven by the need for more durable and effective dental materials. Current limitations in glass-ionomer cements lead to frequent repairs, which reduce patient comfort and increase treatment costs. The innovative materials developed in this project have the potential to address these issues, providing longer-lasting dental restorations, improving patient satisfaction, and reducing the need for replacements or repairs. The expected outcomes of the project include the creation of more wear-resistant glass-ionomer cements and significant advancements in the fields of materials science, tribology, and biomaterials engineering. This knowledge can pave the way for future clinical implementations, contributing to progress in modern dentistry and patient care.